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## **Chapter 6. 2040 Build Conditions and Preliminary Analysis**

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### **6.1 US Route 1**

Two build scenarios for the cross-sectional configuration of mainline US Route 1 underwent preliminary analysis:

- Build Scenario 1 – Six-lane cross section for entirety of study area (Joplin Road/Fuller Road to Telegraph Road)
- Build Scenario 2 – Six-lane cross section between Joplin Road/Fuller Road and Russell Road and eight-lane cross section between Russell Road and Telegraph Road

Both scenarios were analyzed using the forecasted 2040 peak hour volumes. The traffic volume forecasting process was discussed in Chapter 2. The 2040 AM and PM peak hour volumes are shown in **Figure 6-1** and **Figure 6-2**. Detailed Synchro/HCM results for Build Scenarios 1 and 2 for year 2040 can be found in Appendix E.

#### **6.1.1 Build Scenario 1**

Build Scenario 1 consists of a six-lane cross section of US Route 1 throughout the study area. The proposed typical is configured as a six-lane divided facility with raised medians and curb and gutter replacing the existing outside open shoulders. The proposed lanes are 12 feet wide and the proposed median is 28 feet wide, such that two-lane turn bays can be accommodated. In addition to the travel lane improvements, pedestrian and bicycle access are also considered. A 10-foot multiuse path on the west side and a six-foot sidewalk on the east side of US Route 1 are proposed.

Additional turn lanes and minor improvement to side-street approaches not present in the no-build scenario were added based on preliminary intersection analysis.

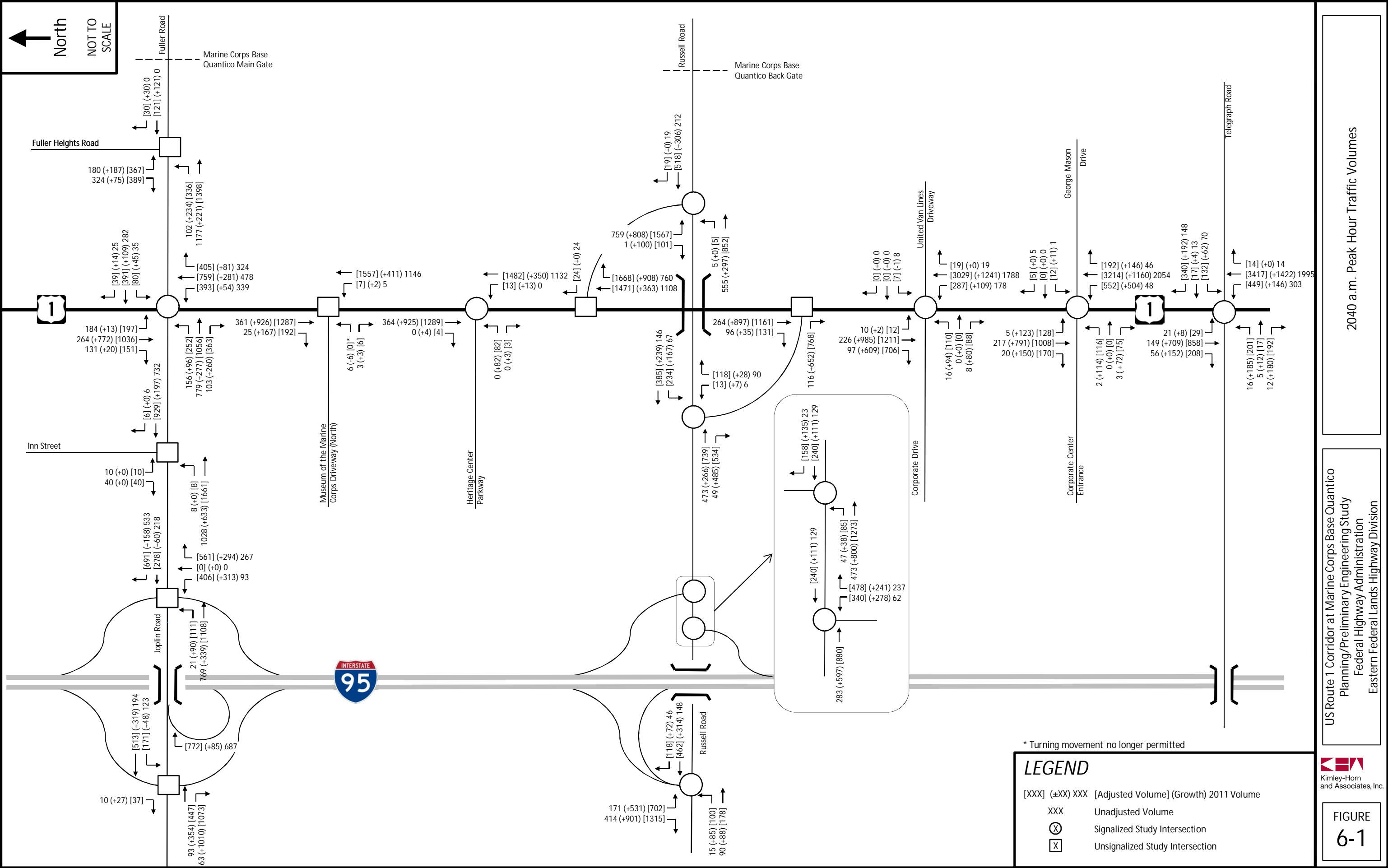
#### **6.1.2 Build Scenario 2**

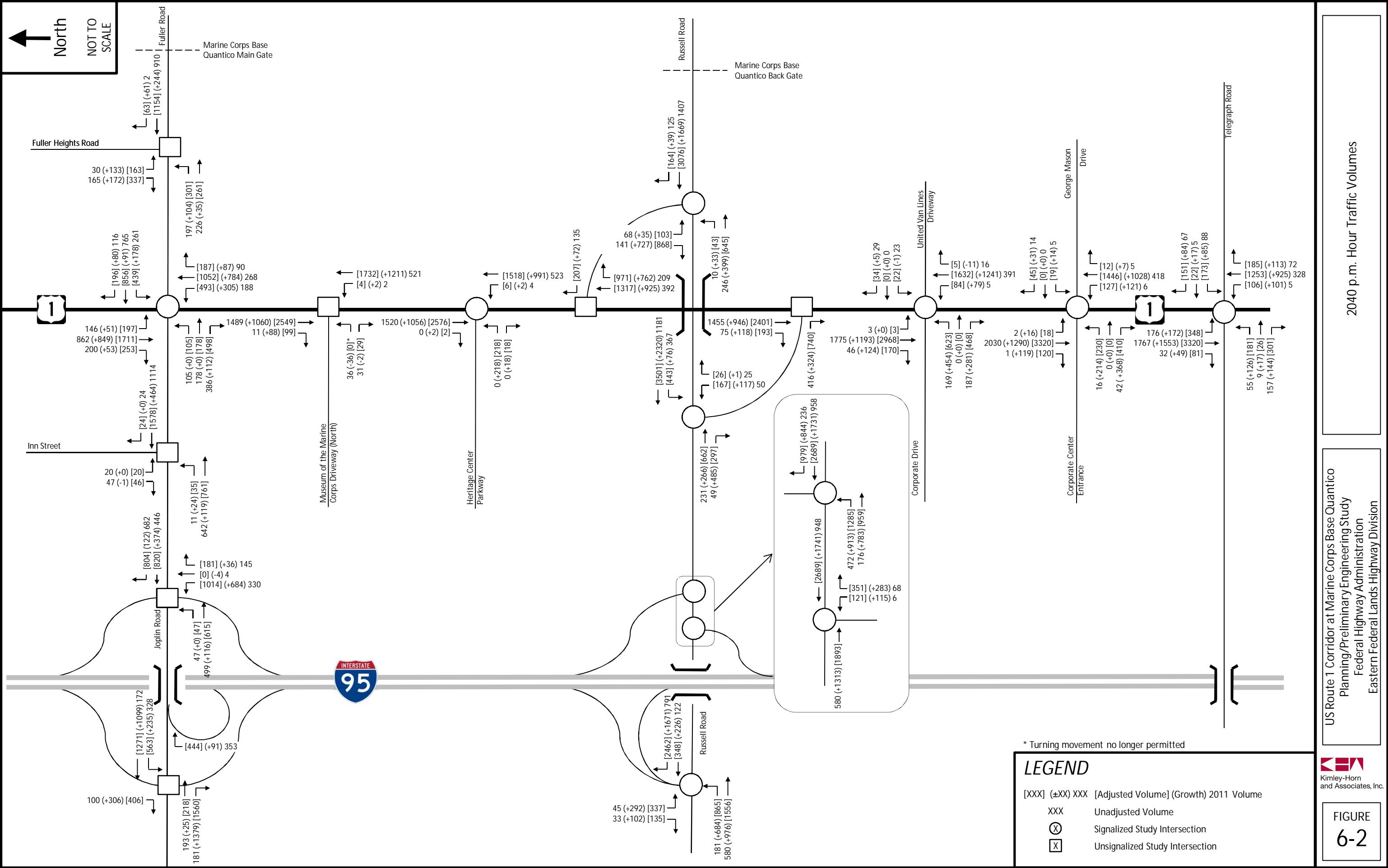
Build Scenario 2 involves the same cross-section for US Route 1 north of Russell Road as Build Scenario 1. South of Russell Road, an eight-lane cross section was analyzed due to the high traffic volumes forecasted as a result of expected development and growth in areas such as the Quantico Corporate Center, Boswell's Corner, and Westside MCB Quantico. The fourth lane in each direction is added and dropped at the interchange ramps. In addition to the travel lane improvements, pedestrian and bicycle access are also considered. A 10-foot multiuse path on the west side and a six-foot sidewalk on the east side of US Route 1 are proposed. Turn-lane lengths and side-street approach lane configurations were adjusted based on the preliminary analysis.

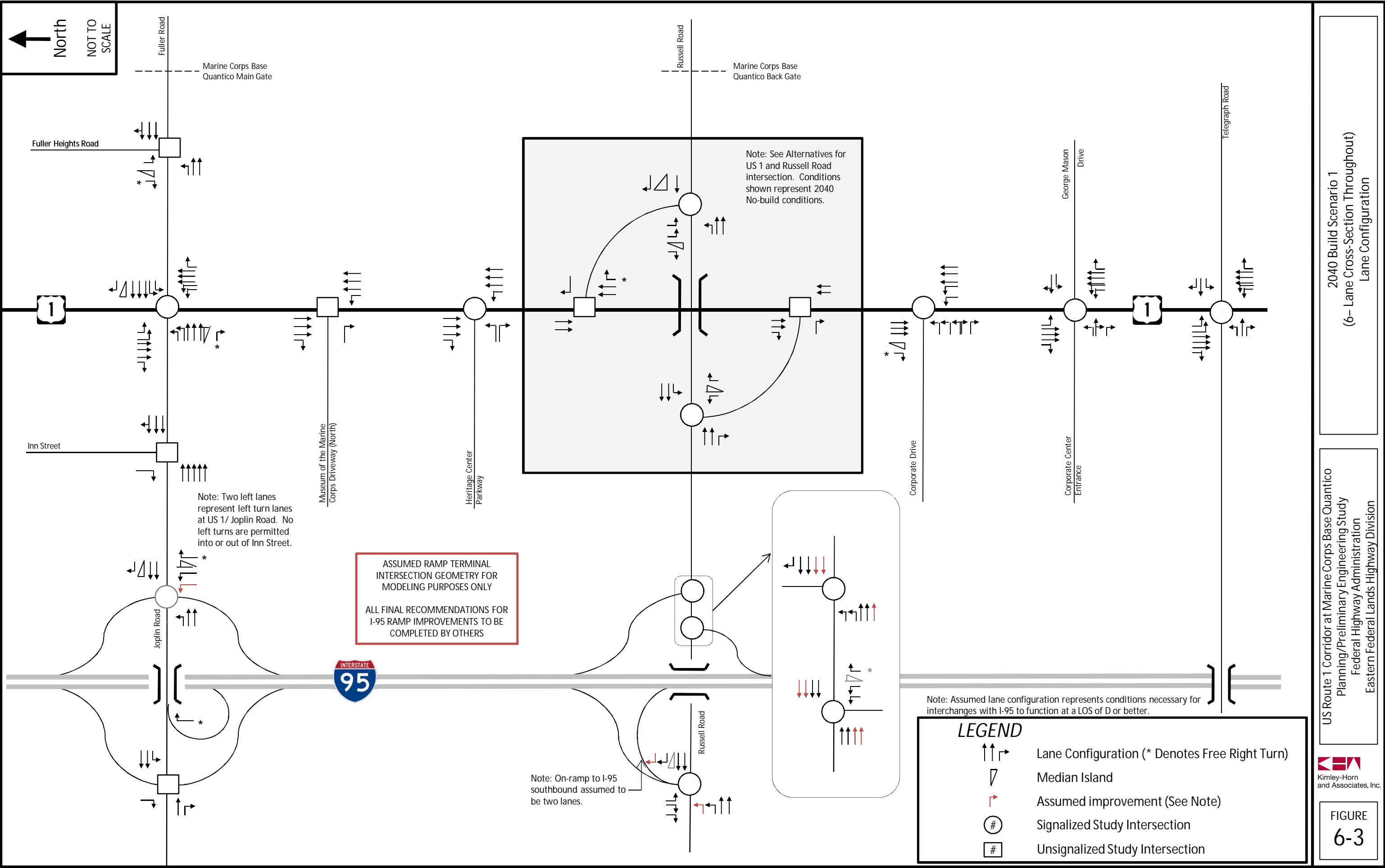
With the intention of minimizing the right-of-way impacts of the eight-lane section, other options were considered (although these options are not shown with the conceptual plans). These options included interchanges and interchange/collector-distributor (CD) road combinations at specific existing intersections. It was determined that these options had more impact to on the adjacent properties than the eight-lane mainline alternative. For this reason, these alternatives were not further evaluated.

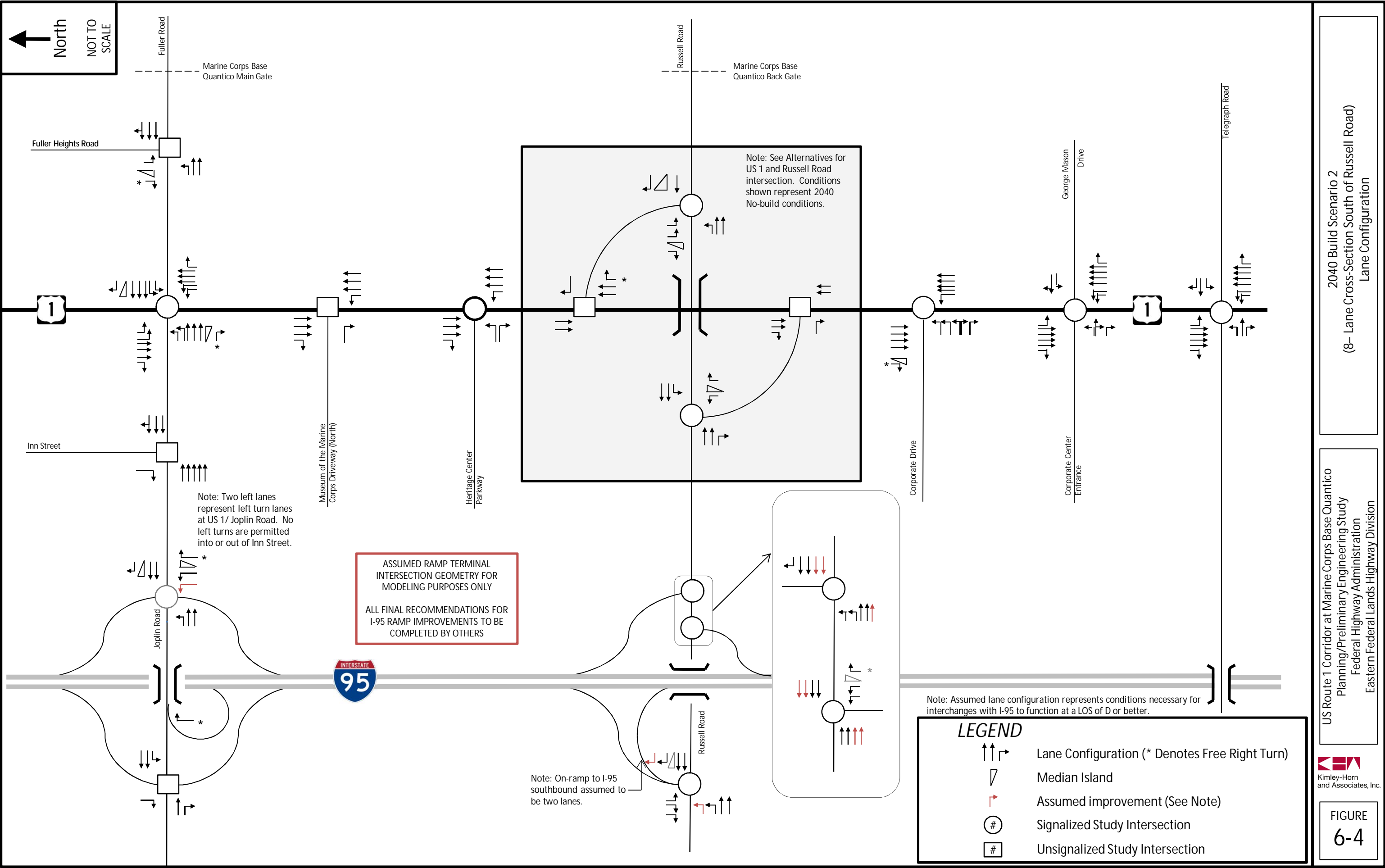
#### **6.1.3 Geometric Considerations**

The lane and traffic control conditions each scenario are shown in **Figure 6-3** and **Figure 6-4**. It should be noted that lane and traffic control conditions for the I-95 interchanges at Joplin and Russell Road are necessary to accommodate the forecast traffic to US Route 1 were assumed. These assumed conditions are reflected in the corresponding figures.









### **Centerline Alignment**

North of Russell Road, in Prince William County, the initial intention was to widen US Route 1 to the east, avoiding any impacts to Locust Shade Park. The area of potential impact for this design was determined to encroach on MCB Quantico property and would impact the military housing located in close proximity to US Route 1. It was ultimately proposed that the existing centerline remain as to minimize impacts to the park without encroaching on the military housing.

South of Russell Road, in Stafford County, US Route 1 is lined by commercial and residential partials. In efforts to reduce impact to these properties, three US Route 1 alternatives were evaluated:

- The proposed centerline was centered on the existing right-of-way, impacting somewhat equally the properties on both sides of the road
- Limiting potential impact to not extend past the westernmost right-of-way line, impacting only the properties on the east side of the road
- Limiting potential impact to not extend past the easternmost right-of-way line, impacting only the properties on the west side of the road

These three mainline alignments were presented to stakeholders and at a citizen information meeting. Based on the input received at these meetings, it was decided to use the centerline centered within the existing right-of-way lines (first option), as the preferred alignment. Future, more detailed design of US Route 1 would include refinement of the alignment to even further limit the impacts.

### **Alternative Configurations**

With an intent to minimize the right-of-way impacts of the eight-lane section, other options beside at-grade intersections were considered. These options included interchanges and interchange-CD road combinations at specific existing intersections. It was determined that these options would have an even larger footprint of impact than the at-grade options. For this reason, these alternatives were not further evaluated.

### **Horizontal & Vertical Alignment**

The design of the two build alternatives also corrected horizontal and vertical curves which were identified as deficient or identified as a safety concern in Chapter 2. These improvements will ensure that the road satisfies Virginia Department of Transportation (VDOT) requirements and will improve the safety for drivers, pedestrians and bikers.

#### **6.1.4 Preliminary Analysis**

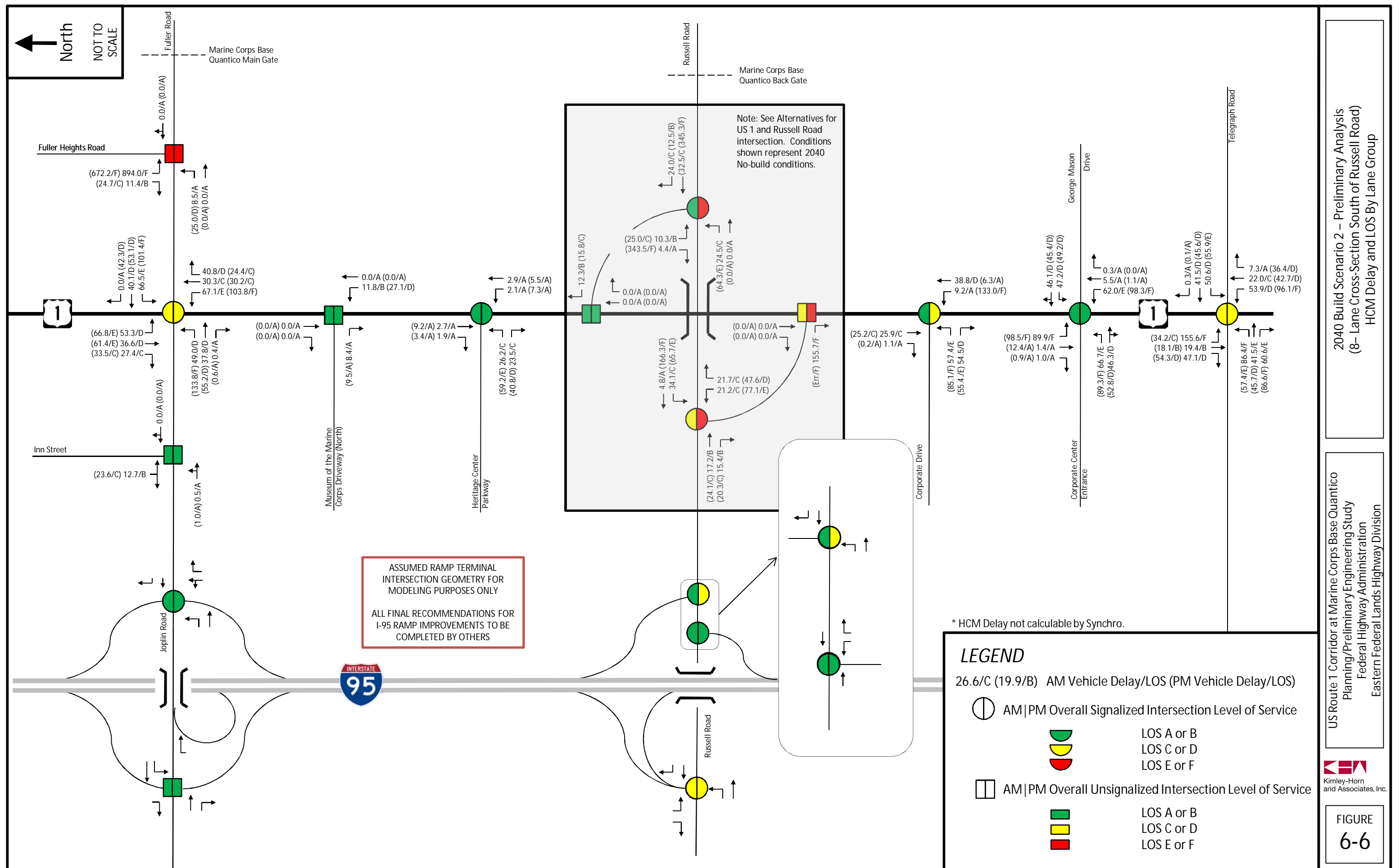
Signalized intersections were analyzed based on overall level of service and delay as well as capacity and expected queuing. Intersection capacity analyses were performed using *Synchro*, Version 7, which uses methodologies in the *Highway Capacity Manual (HCM), 2000 Edition* for signalized and unsignalized intersections. The results of the traffic analysis for the No-Build and both build scenarios at all signalized intersections are presented in **Table 6-1**. As previously discussed in Chapter 3, the no-build scenario has almost all of the intersections operating at LOS F. Build Scenario 1 and 2 both show all intersections operating at an acceptable level of service. In both build scenarios, the delay in the PM peak hour is higher than that of the AM peak hour.

Table 6-1: US Route 1 Signalized Intersection Capacity Results (Synchro/HCM)

Signalized Intersections	Scenario					
	2040 No-Build		2040 Build Scenario 1		2040 Build Scenario 2	
	Level of Service	Delay, sec/veh	Level of Service	Delay, sec/veh	Level of Service	Delay, sec/veh
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
US Route 1 Lanes (Joplin Road to Russell Road)	4		6		6	
1 US Route 1 and Joplin Road/Fuller Road	F (F)	154.0 (152.2)	D (D)	37.7 (54.6)	D (D)	37.7 (54.6)
2 US Route 1 and Heritage Center Parkway	A (C)	3.9 (26.6)	A (B)	3.5 (10.5)	A (B)	3.5 (10.5)
US Route 1 Lanes (Russell Road to Telegraph Road)	4		6		8	
3 US Route 1 and Corporate Drive/Business Driveway	F (F)	102.6 (213.6)	A (D)	8.4 (51.7)	B (C)	12.6 (30.4)
4 US Route 1 and George Mason Drive/Corporate Center Entrance	F (F)	117.4 (140.2)	B (D)	19.5 (35.6)	B (B)	14.1 (18.1)
5 US Route 1 and Telegraph Road	F (F)	186.7 (198.5)	D (D)	45.8 (53.9)	C (C)	25.5 (29.6)

Individual movement delays and levels of service for US Route 1 intersections in Build Scenario 1 and Build Scenario 2 are depicted in **Figure 6-5** and **Figure 6-6**.





### V/C Ratio and Queuing

In addition to overall delay and level of service, signalized intersection on US Route 1 were also analyzed based on volume to capacity (v/c) ratio and 95<sup>th</sup> percentile queue length. A v/c ratio greater than 1.0 indicated that the demand traffic volume is greater than the available capacity, which results in high delays and long queues at the intersection. Results for v/c and queuing are shown in **Table 6-2**.

**Table 6-2: Signalized Intersection Volume to Capacity Ratios & Queuing  
(Synchro/HCM)**

Signalized Intersections	Scenario					
	2040 No-Build		2040 Build Scenario 1		2040 Build Scenario 2	
	Maximum Thru Movement V/C Ratio	Maximum Thru Movement 95th Percentile Queue Length (feet)	Maximum Thru Movement V/C Ratio	Maximum Thru Movement 95th Percentile Queue Length (feet)	Maximum Thru Movement V/C Ratio	Maximum Thru Movement 95th Percentile Queue Length (feet)
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
<b>US Route 1 Lanes (Joplin Road to Russell Road)</b>	4		6		6	
1 US Route 1 and Joplin Road/Fuller Road	1.14 (1.38)	831 (1430)	0.73 (0.99)	340 (790)	0.73 (0.99)	340 (790)
2 US Route 1 and Heritage Center Parkway	0.57 (1.01)	825 (1350)	0.43 (0.74)	91 (507)	0.43 (0.74)	91 (507)
<b>US Route 1 Lanes (Russell Road to Telegraph Road)</b>	4		6		8	
3 US Route 1 and Corporate Drive/Business Driveway	1.2 (56)	2381 (2504)	0.78 (1.06)	260 (1,360)	0.7 (0.84)	300 (750)
4 US Route 1 and George Mason Drive/Corporate Center Entrance	1.3 (1.4)	2471 (2603)	0.97 (1.05)	180 (1,463)	0.83 (0.91)	240 (730)
5 US Route 1 and Telegraph Road	1.54 (1.58)	2841 (2850)	1.04 (1.09)	1540 (1,370)	0.91 (0.95)	770 (550)

The no-build scenario shows the worst v/c ratios and maximum queues. V/c ratios are greater than 1.0 for four of the five signalized intersections. Extremely large queues are present at all five intersections.

In Build Scenario 1, the intersections south of Russell Road operate with peak through movements at a v/c ratio greater than 1.0 in the PM peak hour. The intersection of US Route 1 and Telegraph Road has a v/c ratio greater than 1.0 in the AM peak hour. The three intersections south of Russell Road have estimated 95th percentile queue lengths of more than 1,300 feet in the PM peak hour. While these queues are somewhat excessive, they do not spill back through upstream intersections. These results demonstrate the potential for queuing issues along the corridor. However, the HCM calculations only report the conditions for the highest volume 15-minute period within the peak hour. They are not able to determine the effects of queues building up over the entire peak hour. If an approach is only over capacity for the peak 15 minutes, then these queuing results are valid. If an approach is over capacity throughout the peak hour, the queues will continue to build up and may be longer than reported by the HCM equations. Further analysis using VISSIM microsimulation was conducted to fully gauge the queuing conditions when the demand volumes are at or above capacity. The results are documented in Chapter 6.

In Build Scenario 2, all intersections have through movement v/c ratios of less than 1.0 and 95<sup>th</sup> percentile queues less than 800 feet indicating that all intersections operate at acceptable levels of service and queuing.

## **6.2 US Route 1/Russell Road Interchange**

As described in Chapter 4, three concepts for the Russell Road/US Route 1 interchange were carried forward for further evaluation – Alternatives A, E, and G.

- Alternative A signalizes the existing ramp intersections on Russell Road and adds a direct ramp from northbound US Route 1 to eastbound Russell Road
- Alternative E is a full cloverleaf interchange with free flow ramps for all movements
- Alternative G is a combination of the other two, with a signalized intersection on Russell Road on the west side of US Route 1, and a half cloverleaf on the east side of US Route 1

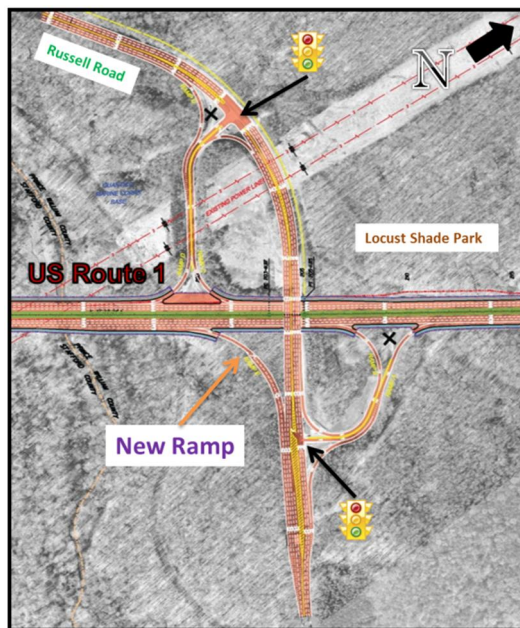
### **6.2.1 Traffic Operations Analysis (Synchro/HCM)**

Given that the signals in the various concepts had different locations, configurations, and number of vehicles, an overall comparison of vehicle-hours of delay to provide a more accurate comparison of the overall vehicle delays for the entire interchange. **Table 6-3** summarizes the results for the three concepts that underwent preliminary analysis.

Table 6-3: US Route 1/Russell Road Interchange Operational Comparison

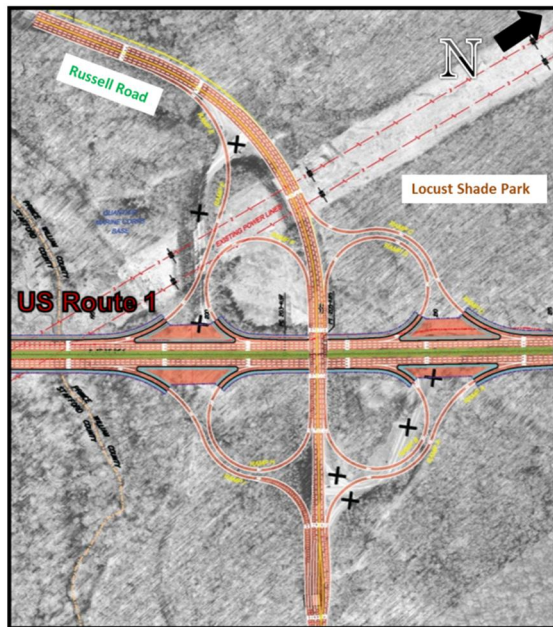
Concept	Peak Hour	Total Intersection Delay (Seconds)	Total Vehicles Under Signal Control	Total Intersection Delay (Vehicle Hours)	Weighted Average of Total Delay (Vehicle Hours)
No-Build	AM	32	3,699	33	786
	PM	435	9,053	1,093	
A	AM	16	2,031	9	55
	PM	29	8,082	66	
E	AM				
	PM				
G	AM	2	976	1	9
	PM	12	3,439	11	

From the perspective of average total vehicle hours of delay, Concept E is the best operational alternative because all movements are free flow and there are no traffic signals. However, traffic operations were not the only factor in the evaluation. Based on these results and discussions with the project stakeholders, the following methodology was followed.



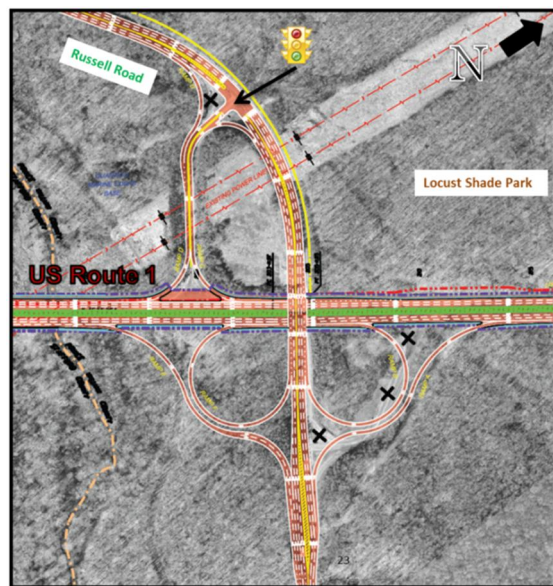
### 1. Concept A

This alternative does not meet security standards for maintaining traffic flow outside security gates. The proposed traffic signal on Russell Road at the ramps to US Route 1 is located too close to the MCB Quantico Back Gate. **This alternative was removed from consideration.**



## 2. Concept E

Because this alternative has free flow ramps for all traffic movements, there is little to no vehicle delay. However, the proposed ramps in the northwest quadrant would require right-of-way acquisition of Locust Shade Park property. To gain environmental clearance for this alternative, it would be necessary to demonstrate that there are no other viable alternatives to accommodate design year traffic volumes.



## 3. Concept G

This alternative eliminates the security requirement issues with Concept A while minimizing the impacts to park property associated with Concept E. The signalized intersection on Russell Road west of US Route 1 is far enough away from the MCB Quantico Back Gate to not impeded traffic flow, and a traffic analysis using Synchro/HCM indicates that it will operate at an acceptable LOS B during the AM peak and LOS C in the PM peak with design year 2040 peak hour traffic volumes.

## 6.3 Conclusions

Below are the conclusions drawn from the comparison of the preliminary operational analysis results of the no-build alternative to the two US Route 1 build scenarios and the six US Route 1/Russell Road interchange concepts.

### 6.3.1 US Route 1

The no-build scenario for US Route 1 will not provide adequate intersection or link capacity on US Route 1.

Under Scenario 1 (six-lane cross section throughout study area), all intersections operate at acceptable levels of service in both peak hours. Although, the overall intersection level of service is at an acceptable value, the Synchro/HCM analysis showed that the peak direction through movements on US Route 1 at intersections south of Russell Road operate with a v/c ratio of over 1 and have some potentially sizeable queues. However, Synchro/HCM methodology is less accurate when intersections are over capacity. Full microsimulation analysis was conducted to determine the functioning of the overall system. The results of this analysis are documented in Chapter 7.

From an operational perspective, the best option is Scenario 2 (six-lane section from Joplin Road/Fuller Road to Russell Road and eight-lane section from Russell to Telegraph Road). Under this scenario, all intersections operate at a level of service D or lower and all through movement v/c ratios are under 1.0. However, widening to eight lanes would have a much greater cost and impact to the businesses along US Route 1. This option should only be considered if detailed microsimulation results from the six-lane scenario indicate unacceptable congestion.

### **6.3.2 Russell Road**

The current configuration of the US Route 1 and Russell Road interchange is not capable of handling the growth in traffic volumes forecast for 2040. Of the three secondary concepts for US Route 1/Russell Road interchange, Concept G operates the most effectively, meets the needs of the project stakeholders, and minimizes environmental impacts. The recommended concept for the US Route 1/Russell Road interchange is Concept G.